

## **REMARKS**

Applicant submits herewith new claims 43-58 which are based on claims 1-16 as amended on October 23, 2003. Applicant notes with appreciation the allowance of claims 37-39. Applicant is canceling claims 36-42 without prejudice to the filing of a divisional application, at which time Applicant will respond to the Examiner's prior rejection of these claims.

In the following remarks, Applicant responds to the Examiner's prior rejections of claims 1-16 (now pending claims 43-58).

The Examiner rejected prior claims 1-16 as being obvious over Nakamura JP 08222374A in view of H. Michaelson, "The Work Function of the Elements and Its Periodicity," Journal of Applied Physics, Volume 48 Number 11, November 1977, pages 4729-4733. Nakamura (see enclosed English-language machine translation) discloses an arrangement for reducing reflection of external light and enhancing contrast in an organic light-emissive device by providing a charge injection type light-absorbing/diffusing layer. Nakamura does not disclose "a fluoride or oxide of a metal having a work function of 3.5 eV or less" as required by claim 43. Rather, Nakamura discloses a cathode comprising a mixture of a light-absorbing material and a metal having a work function of 4.0 eV or less (see Abstract). The light-absorbing material appears to be graphite or a compound of Formula 1 (see, for example, ¶¶ 9-13). The metal of a low work function provides a good charge injection. Nakamura does refer to metal oxides, but the only such oxides mentioned are ITO, SnO<sub>2</sub> and ZnO used in the anode, and AlO<sub>2</sub> used in the cathode (see ¶¶ 14 and 15). None of these oxides are of a metal having a work function of less than 3.5 eV.

In contrast, an advantage of the presently claimed device is that a fluoride or oxide of a metal having a work function of less than 3.5 eV, if provided in sufficient quantity, can function both to inject electrons and also to absorb light. This is not suggested in any of the prior art. Instead, Nakamura discloses the use of two separate components: a metal having a work function of less than 4.0 eV for electron injection, and a light-absorbing material such as graphite or an organic compound of Formula 1.

Michaelson fails to cure the deficiencies of Nakamura. Thus, Applicant respectfully asserts that claims 43-58 are patentable over Nakamura and Michaelson.


In view of the foregoing amendments and remarks, Applicant respectfully requests reconsideration and reexamination of this application and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

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3. In the drawings, any words are not translated.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] About an organic electroluminescence (it is hereafter written as EL) element, this invention establishes an optical-absorption diffusion layer with an organic luminous layer between the electrodes of a couple, or prevents reflex of outdoor daylight still in detail, by making it what has an optical-absorption diffusibility for any of the electrode of a couple, or one side, and relates to the organic EL element which raised contrast remarkably.

[0002]

[Description of the Prior Art] Since it has the characteristic features, like it is excellent in shock resistance since the EL element using the electroluminescence has high visibility and is a perfect solid-state component because of self-photogenesis, the use as a light emitting device in various display attracts attention. Since there is an organic EL element which comes to use for this EL element the inorganic EL element which comes to use an inorganic compound for luminescent material, and an organic compound, among these an organic EL element can make applied voltage low sharply, the utilization research is positively made as a display device of the next generation. The above-mentioned organic EL element is equipped with the organic compound layer which contains a luminous layer at least, and the electrode of the couple which pinches this organic compound layer, and, specifically, the thing of configurations, such as what prepared the hole-injection layer and the electron-injection layer in this suitably on the basis of the configuration of an anode plate / luminous layer / cathode, for example, an anode plate / hole-injection layer / luminous layer / cathode, and an anode plate / hole-injection layer / luminous layer / electron-injection layer / cathode, is known. This hole-injection layer has the function to transmit the electron hole poured in from the anode plate to a luminous layer, and the electron-injection layer has the function to transmit the electron poured in from cathode to a luminous layer. And many electron holes are poured into a luminous layer by the lower electric field by making this hole-injection layer intervene between a luminous layer and an anode plate, and it is known further that it will be accumulated at the interface of a hole-injection layer and a luminous layer since a hole-injection layer does not convey an electron, and luminous efficiency will go up the electron poured into the luminous layer from cathode or the electron-injection layer.

[0003] In the organic EL element of such a configuration, if a voltage is impressed to inter-electrode [ of a couple ], in a luminous layer, an exciton will arise by the reunion with the electron hole poured in from the electron poured in from cathode, and the anode plate, and light will be emitted in the process in which this exciton carries out radiation deactivation. And at least one side is translucent among the electrodes of a couple, and light is emitted to the exterior through this transparent or translucent electrode. However, in the conventional organic EL element, since light was made to emit and this light was taken out from the transparent substrate side by impressing a voltage to the organic stratum functionale which consists of an organic luminous layer, a hole-injection layer prepared by the case, an electron-injection layer, etc. as described above, there was a problem that contrast fell remarkably, for example by reflex of the outdoor daylight from metal system cathode. Moreover, there was same problem also in an inorganic EL element. The organic EL element which has an optical-absorption diffusion layer on the outside of an electrode in order to solve such a problem is proposed (JP,6-5367,A). However, in this EL

element, the metal system electrode needed to be thinly produced so that it might become translucent, and there was a problem that it did not escape that the injection nature of the charge from this electrode falls as a result. Although the inorganic EL element which has an optical-absorption layer or an optical-absorption nature electrode is indicated (international patent public presentation of No. 14298 [ 94 to ], 94-14299), since this inorganic EL element is the structure where the luminous layer was inserted into the insulating layer, on the other hand, the material currently indicated there is inapplicable to what emits light by injection of a charge like an organic EL element.

[0004]

[Problem(s) to be Solved by the Invention] this invention improves the fault which such a conventional organic EL element has, prevents reflex of outdoor daylight, and aims at offering the organic EL element which raised contrast remarkably.

[0005]

[Means for Solving the Problem] As a result of repeating a research zealously that this invention persons should develop the organic EL element which raised contrast, between the electrodes of a couple transparent [ at least one ] or translucent, any of the electrode of the thing which established the charge injection nature optical-absorption diffusion layer with the organic luminous layer, or a couple, or one side was transparent or translucent, and that in which the remainder has an optical-absorption diffusibility found out that the purpose might be suited. this invention is completed based on such knowledge. Namely, between the electrodes of a couple transparent [ first at least one purpose of this invention ], or translucent It is in offering the organic EL element which comes to pinch an organic luminous layer and a charge injection nature optical-absorption diffusion layer. the second purpose In the organic EL element which pinches an organic luminous layer between the electrodes of a couple, any of this electrode or one side is transparent or translucent, and it is in offering the organic EL element characterized by the remainder having an optical-absorption diffusibility. The organic EL element of the first invention pinches an organic luminous layer and a charge injection nature optical-absorption diffusion layer as an indispensable configuration layer between the electrodes of a couple. In this element, when that the electrode of the above-mentioned couple needs for at least one side to be transparent or translucent, and only the electrode in contact with this substrate is transparent [ an EL element ] since an organic EL element carries out the laminating of an electrode and each class and is usually produced on substrates, such as glass and a product made from plastics, or translucent, it is required for a substrate to be also transparent or translucent. It is the thing of the operation passed to the charge injection layer which the above-mentioned charge injection nature optical-absorption diffusion layer has both the functions of an optical-absorption diffusibility and charge injection nature, and an optical-absorption diffusibility says the operation which absorbed or diffuses the light, on the other hand, thinks an electron or an electron hole to be charge injection nature from an electrode or a charge injection layer here, and is in contact with the optical-absorption diffusion layer, and a luminous layer. Since photogenesis arises when it is poured in in an organic EL element to a luminous layer through the hole-injection layer in which the electron hole from an anode plate is established by the case, and is poured in to a luminous layer through the electron-injection layer in which the electron from cathode is prepared by the case on the other hand and an electron and an electron hole recombine here, it is required for the optical-absorption diffusion layer established between two electrodes to also have charge injection nature. That is, when establishing an optical-absorption diffusion layer between cathode and a luminous layer, this optical-absorption diffusion layer needs to have electronic injection nature at least among charge injection nature, and when establishing an optical-absorption diffusion layer between an anode plate and a luminous layer conversely, this optical-absorption diffusion layer needs to have the injection nature of an electron hole at least among charge injection nature.

[0006] Although various modes are in the organic EL element of this first invention For example, it sets to the conventional organic EL element which pinches the organic stratum functionale which contains an organic luminous layer as an indispensable configuration layer between the electrodes of (1) couple. Between the electrodes of the thing which established the charge

injection nature optical-absorption diffusion layer further between the electrodes of a couple, and (2) couples In the conventional organic EL element which pinches the organic stratum functionale containing an organic luminous layer, and a hole-injection layer and/or an electron-injection layer, what gave the function of an optical-absorption diffusibility to the hole-injection layer and/or the electron-injection layer can be mentioned as a desirable mode. About the configuration of the organic EL element in the mode of the above (1) Although there is especially no limit, for example that what is necessary is just the thing of a configuration of pinching an organic luminous layer and a charge injection nature optical-absorption diffusion layer as an indispensable configuration layer between the electrodes of a couple between the electrodes of a couple (a) The thing which comes to pinch an organic luminous layer, (b) hole-injection layer and/or an electron-injection layer, and (c) charge injection nature optical-absorption diffusion layer can be mentioned preferably. What prepared the charge injection nature optical-absorption diffusion layer in the suitable position between an anode plate and cathode as an example of such a thing in element configurations, such as \*\* anode plate / organic luminous layer / cathode, \*\* anode plate / hole-injection layer / organic luminous layer / cathode, \*\* anode plate / organic luminous layer / electron-injection layer / cathode, and \*\* anode plate / hole-injection layer / organic luminous layer / electron-injection layer / cathode, can be mentioned. Although the laminating of these is usually carried out on substrates, such as glass and a product made from plastics, there is especially no limit about the built-up sequence to a substrate, and even if it carries out a laminating from an anode plate, you may carry out a laminating from cathode. [0007] In the organic EL element of these configurations, as a desirable thing, especially (\*\*) anode plate / hole-injection layer / optical-absorption diffusion layer / organic luminous layer / cathode, (\*\*) anode plate / hole-injection layer / ~~optical-absorption diffusion layer~~ / organic luminous layer / electron-injection layer / cathode, (c) An anode plate / optical-absorption *on anode side* diffusion layer / hole-injection layer / organic luminous layer / cathode, (\*\*) anode plate / optical-absorption diffusion layer / hole-injection layer / organic luminous layer / electron-injection layer / cathode, (e) The thing of the configuration of an anode plate / hole-injection layer / organic luminous layer / optical-absorption diffusion layer / cathode, (\*\*) anode plate / hole-injection layer / organic luminous layer / electron-injection layer / ~~optical-absorption diffusion layer~~ / cathode, or (\*\*) anode plate / hole-injection layer / organic luminous layer / optical-absorption diffusion layer / electron-injection layer / cathode can be mentioned. In the organic EL element of the above-mentioned element configuration, it is an electrode transparent [ an anode plate ] or translucent, and when cathode is a metal system electrode, the configuration of the above-mentioned (e), (\*\*), and (g) is advantageous. It is because, as for this ground, an optical-absorption diffusion layer carries out absorption dispersion only of the outdoor daylight with the configuration of (e), (\*\*), and (g) and photogenesis of an organic EL element is observed from a direct transparent electrode. Conversely, cathode is transparent or translucent, and when taking out light from a cathode side, the configuration of the above-mentioned (b), (b), (c), or (d) is advantageous. Moreover, the hole-injection layer and the electron-injection layer may consist of a layer of an itself plurality so that it may mention later. Therefore, it may be inserted between charge injection layers like an anode plate / the 1st hole-injection layer / optical-absorption diffusion layer / 2nd hole-injection layer. Drawing 1 is a cross section showing an example of an element configuration in case it is an electrode transparent [ an anode plate ] or translucent in the organic EL element of this invention and cathode is a metal system electrode, and the laminating of the cathode 6 which consists of the transparent or translucent anode plate 2, the hole-injection layer 3, the organic luminous layer 4, an optical-absorption diffusion layer 5, and a metal system electrode on the transparent substrate 1 is carried out one by one.

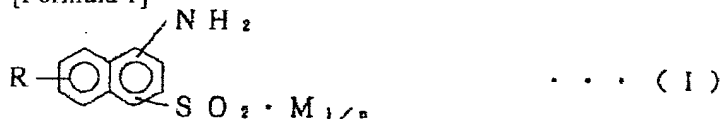
[0008] Next, the organic EL element in the mode of the above (2) will give the function of an optical-absorption diffusibility to a hole-injection layer and/or an electron-injection layer, a hole-injection layer will have both the functions of hole-injection nature and an optical-absorption diffusibility, and an electron-injection layer will have both the functions of electron-injection nature and an optical-absorption diffusibility. Although there are various things as a configuration of such an organic EL element, (h) anode plate / optical-absorption diffusibility hole-injection layer / organic luminous layer / cathode, (i) anode plate / an optical-absorption diffusibility hole-

injection layer / organic luminous layer / electron-injection layer / cathode, (j) anode plate / organic luminous layer / optical-absorption diffusibility electron-injection layer / cathode, (\*\*) anode plate / a hole-injection layer / organic luminous layer / optical-absorption diffusibility electron-injection layer / cathode can be mentioned, for example. In the organic EL element of the above-mentioned element configuration, it is an electrode transparent [ an anode plate ] or translucent, the configuration of the above-mentioned (j) and (\*\*) is advantageous by the ground as the above nil why it is the same when cathode is a metal system electrode, and when cathode is transparent or translucent and it takes out light from a cathode side, the configuration of the above-mentioned (h) and (i) is conversely advantageous. The above-mentioned optical-absorption diffusibility hole-injection layer and an optical-absorption diffusibility electron-injection layer are producible by making a hole-injection layer and an electron-injection layer contain the optical-absorption diffusibility matter.

[0009] As matter which has the function of both the charge injection nature which forms a charge injection nature optical-absorption diffusion layer, and an optical-absorption diffusibility in the organic EL element of this invention n-SiC and a graphite are begun when preparing this optical-absorption diffusion layer in a cathode side from an organic luminous layer. As an electron-injection layer later mentioned with the mixture with the metal of 4.0eV or less of the work functions later mentioned with a metallic oxide, the mixture with the organic compound preferably used for the electron-injection layer later mentioned with a metallic oxide, and the metal of 4.2eV or less of work functions The mixture (it is specifically the mixture of aluminum and tris (8-hydroxyquinoline) aluminum etc.) with the organic compound used preferably, the metal ultrafine particle (about 100 micrometers or less of mean particle diameters) of 4.0eV or less of work functions, etc. are mentioned. Furthermore, a general formula (I)

[0010]

[Formula 1]



[0011] In the inside of [formula, and R, an alkyl group and M show alkaline earth metal, such as alkali metal, such as sodium and a potassium, or calcium, and n shows the valence of M. ] It can come out and the compound (water of crystallization may be included) expressed can be used, and the vacuum deposition layer of this compound absorbs the light as indicated by JP,64-17849,A. Two or more sorts of these matter may be combined, and it may be used. The mixture with the organic compound used for the mixture, and the metal and electron-injection layer of 4.2eV or less of work functions with the organic compound used for a metallic oxide and an electron-injection layer in the compound which has the function of both the above-mentioned charge injection nature and an optical-absorption diffusibility can be used also for formation of the optical-absorption diffusibility electron-injection layer in the mode of the above (2). On the other hand, when preparing an optical-absorption diffusion layer in an anode plate side from an organic luminous layer, as matter which has the function of both charge injection nature and an optical-absorption diffusibility For example, the mixture with the metal of 4.0eV or more of the work functions which begin a graphite and are later mentioned with a metallic oxide, The mixture with the organic compound preferably used for the hole-injection layer later mentioned with a metallic oxide, the mixture with the organic compound preferably used for the hole-injection layer later mentioned with the metal of 4.2eV or more of work functions, the metal ultrafine particle of 4.0eV or more of work functions (about 100 micrometers or less of mean particle diameters), Or the compound which has absorption in the lights, such as a polyacetylene, is mentioned. Moreover, two or more sorts of these matter may be combined, and it may be used. The mixture with the organic compound used for the mixture, and the metal and hole-injection layer of 4.2eV or more of work functions with the organic compound used for a metallic oxide and a hole-injection layer in the compound which has the function of both the above-mentioned charge injection nature and an optical-absorption diffusibility can be used also for formation of

the optical-absorption diffusibility hole-injection layer in the mode of the above (2).

[0012] Although there is especially no limit, and it can choose out of inside, such as the spin coat method, the cast method, and a vacuum deposition, suitably and it can use according to the matter to use about the production technique of an optical-absorption diffusion layer in the organic EL element of this invention, especially the vacuum deposition method is suitable. When it is easy to obtain a homogeneous layer, if this is produced by the same technique from it being desirable that an organic luminous layer, a hole-injection layer, and an electron-injection layer produce by the vacuum deposition method like [ below-mentioned ], it can be produced, without breaking a vacuum, saving of production time or an effort is possible for it, and it is because mixture of an impurity can be prevented. Although vacuum evaporation conditions differ according to the modality of matter used for an optical-absorption diffusion layer when adopting this vacuum deposition method, by the case of an organic compound, generally, 50-500 degrees C and a degree of vacuum can be chosen by  $10^{-6}$  to ten to 3 Pa, and an evaporation rate can choose heating temperature suitably a second in the domain with 0.01-50nm [ / ] and a substrate temperature of 50-300 degrees C. On the other hand, in the case of inorganic substances, such as a metal, a metallic oxide, and a graphite, heating temperature usually becomes high with 500-4,000 degrees C. Especially the thing of the high-melting point of a graphite etc. has the sputtering method which can produce the thing of a high-melting point also in a vacuum deposition, an electron-beam-evaporation method, and a desirable arc vacuum deposition among inorganic substances. Thus, about the thickness of the acquired optical-absorption diffusion layer, although there is especially no limit, the domain of 10nm - 100 micrometers is desirable, and the domain which is 10nm - 1 micrometer is especially suitable, and it is \*\*.

[0013] Next, the organic EL element of the second invention pinches an organic luminous layer as an indispensable configuration layer between the electrodes of a couple, and any of this electrode or its one side is transparent or translucent, and the remainder has an optical-absorption diffusibility. In order to give an optical-absorption diffusibility to an electrode, in the case of cathode, you should just produce an electrode with the mixture of the matter and the metal of 4.0eV or less of work functions which have an optical-absorption diffusibility. Here, as a metal of 4.0eV or less of work functions, rare earth metal, such as calcium, Li, Yb, Na, Y, Gd, Ba, Cs, Sr, and Mg, alkali metal, and alkaline earth metal are mentioned, for example. As an example of such cathode, the mixed electrode of the mixed electrode metallurgy group oxide of a graphite and Li and calcium etc. can be mentioned. On the other hand, in the case of an anode plate, you should just produce an electrode with the mixture of the matter and the metal of 4.0eV or more of work functions which have an optical-absorption diffusibility. As a metal of 4.0eV or more of work functions, Au, nickel, Ag, Pt, Cu, etc. are mentioned, for example. The thing same as a configuration of the organic EL element of this second invention as what was illustrated by the aforementioned \*\* - \*\* can be mentioned.

[0014] Drawing 2 is a cross section showing the configuration of an example at the time of giving an optical-absorption diffusibility to cathode in the organic EL element of this invention, and the laminating of the transparent or translucent anode plate 2, the hole-injection layer 3, the organic luminous layer 4, and optical-absorption diffusibility cathode 6' is carried out one by one on the transparent substrate 1. Next, in the organic EL element of this invention, each class other than what was explained until now is explained. First, what uses a large (4eV or more) metal, an alloy, electrical conductivity compounds, such mixture, etc. of a work function as the electrode matter as an anode plate is used preferably. As an example of such electrode matter, dielectric transparent materials, such as metals, such as Au, CuI, indiumtin oxide (it is hereafter written as ITO), SnO<sub>2</sub>, and ZnO, etc. are mentioned. This anode plate can produce these electrode matter by making a thin film form by technique, such as vacuum evaporation and sputtering. When taking out photogenesis from this electrode, it is desirable to make permeability larger than 10%, and below several 100ohms / \*\* of the sheet resistance as an electrode are desirable. Although a thickness is based also on a material, the domain of 10-200nm is usually especially desirable still 10nm - 1 micrometer.

[0015] On the other hand, as cathode, what uses a parvus (4eV or less) metal, an alloy, electrical conductivity compounds, such mixture, etc. of a work function as the electrode matter is used. As

an example of such electrode matter, a sodium and sodium-potassium alloy, magnesium, a lithium, magnesium and a silver alloy, aluminum/AlO<sub>2</sub>, an indium, the rare earth metal, etc. are mentioned. By technique, such as vacuum evaporation and sputtering, this cathode can produce these electrode matter by making a thin film form. Moreover, below several 100ohms / \*\* of the sheet resistance as an electrode are desirable, and especially a thickness usually has the desirable domain of 50-200nm 10nm - 1 micrometer. In addition, in the organic EL element of the first invention, it is required for either [ at least ] the above-mentioned anode plate or cathode to be transparent or translucent, any of an anode plate and cathode or one side is transparent or translucent in the organic EL element of the second invention, and it is required to have an optical-absorption diffusibility, as the remainder described above.

[0016] Moreover, an organic luminous layer provides the interior of a luminous layer with the place of the reunion of the injection function in which an electron hole can be poured in by the anode plate or the hole-injection layer at the time of (1) electric-field impression, and an electron can be poured into it from cathode or an electron-injection layer, the transportation function to which the charge (an electron and electron hole) which carried out (2) injection is moved by the force of the electric field, (3) electrons, and an electron hole, and has the About the modality of luminescent material used for this luminous layer, there is especially no limit and a thing conventionally well-known as an organic luminescent material in an organic EL element can be used. As an example of such an organic luminescent material, fluorescent brighteners, such as a benzothiazole system, a benzimidazole system, and a benzo oxazole system, a metal-chelate-ized oxy-\*\*\*\*\* compound, a styryl benzenoid compound, a \*\*\*\*\* pyrazine derivative, an aromatic dimethyldyne compound, etc. are mentioned. An organic luminous layer is formed only by organic luminescent material, and also you may form it by the mixture with an organic luminescent material, an electron hole transportation material, and/or an electron-injection material etc. As an example of the material of the organic luminous layer in this case The molecular-dispersion polymer system which carried out the little variance of the organic luminescent material, such as a coumarin, into polymers, such as a polymethylmethacrylate, bisphenol A, and a polycarbonate (PC) The polymer system which introduced the \*\*\*\*\* benzene derivative into the polycarbonate skeleton, Or a polyphenylene vinyl A derivative system, a poly-alkyl thiophene (PPV) In conjugate polymers, such as a derivative system, a poly-alkyl fluorene (PAF) derivative system, a polyphenylene (PP) derivative system, and a poly-propine (PA) derivative system, and the polyvinyl carbazole of electron hole transportability, (PAT) The \*\*\*\*\* diazole system derivative of electron-injection nature The distributed system is mentioned.

[0017] Next, a hole-injection layer is a layer which consists of an electron hole transmission compound, it has the function to transmit the electron hole poured in from the anode plate to a luminous layer, and many electron holes are poured into a luminous layer by the lower electric field by making this hole-injection layer intervene between an anode plate and a luminous layer. Moreover, with the obstruction of the electron which exists in the interface of a luminous layer and a hole-injection layer, the electron poured into the luminous layer by cathode or the electron-injection layer is accumulated near the interface in this luminous layer, raises the luminous efficiency of an EL element, and let it be the EL element which was excellent in luminescent ability. About the electron hole transmission compound used for this hole-injection layer, there is especially no limit and it can use a thing conventionally well-known as an electron hole transmission compound in an organic EL element. the example of such an electron hole transmission compound \*\*\*\*\* -- a triazole derivative, a \*\*\*\*\* diazole derivative, an imidazole derivative, a poly-aryl alkane derivative, a pyrazoline derivative, a pyrazolone derivative, a phenylenediamine derivative, an arylamine derivative, an amino substitute chalcone derivative, an oxazole derivative, a styryl anthracene derivative, and full -- me -- non, specific conductive polymer oligomer, such as a derivative, a hydrazone derivative, a stilbene derivative, a silazane derivative, a polysilane system compound, an aniline system polymer, and thiophene oligomer [0018] Furthermore, the electron-injection layer has the function to transmit the electron poured in from cathode to an organic luminous layer. About the electron-transport compound used for this electron-injection layer, there is especially no limit and it can use a thing conventionally well-



known as an electron-transport compound in an organic EL element. As an example of such an electron-transport compound, nitration full -- me -- non -- heterocycle tetrapod carboxylic-acid anhydrides, such as a derivative, an anthra quinodimethan derivative, a diphenyl quinone derivative, a thiopyran dioxide derivative, and a naphthalene perylene, a carbodiimide, and full -- me -- a \*\*\*\*\* methane derivative and an anthrone derivative -- A \*\*\*\*\* diazole derivative and also an eight quinolinol, or the metal complex of the derivative. For example, tris Aluminum, a screw (Eight quinolinol) Magnesium, a screw (Eight quinolinol) Zinc, a screw (Benzo-8-quinolinol) (2-methyl-8-quinolinolato)aluminumoxide, a tris (eight quinolinol) indium, tris (5-methyl-eight quinolinol) aluminum, an eight-quinolinol lithium, a tris (5-\*\*\*\*\*-eight quinolinol) gallium, a screw Calcium, tris (5, 7-dichloro-eight quinolinol) aluminum, tris (5, 7-dibromo-eight quinolinol) aluminum, screw (eight quinolinol) beryllium, (5-\*\*\*\*\*-eight quinolinol) Screw (2-methyl-eight quinolinol) beryllium, screw (eight quinolinol) zinc, screw (2-methyl-eight quinolinol) zinc, screw (eight quinolinol) tin, tris (7-propyl-eight quinolinol) aluminum, etc. are mentioned. In addition, the above-mentioned organic luminous layer, a hole-injection layer, and an electron-injection layer may carry out the laminating of the layer which consists of a material which may consist of one layer which consists of a kind of each material, or two sorts or more, or is different more than a bilayer.

[0019] Next, about the suitable production technique of the organic EL element of this invention, the element which has the configuration of an anode plate / hole-injection layer / organic luminous layer / electron-injection layer / optical-absorption diffusion layer / cathode is mentioned as an example, and is explained. First, on a suitable substrate, 1 micrometer or less of the thin films which consist of desired electrode matter, for example, matter for anode plates, is made to form by technique, such as vacuum evaporation and sputtering, so that it may become the thickness of the domain of 10-200nm preferably, and an anode plate is produced. Next, the thin film which consists of a material of the hole-injection layer which is an element material, an organic luminous layer, an electron-injection layer, and an optical-absorption diffusion layer is made to form one by one on this. Although production of an optical-absorption diffusion layer was already described, as the production technique of other thin films, there are the spin coat method, the cast method, a vacuum deposition, etc. However, the point of a homogeneous layer being easy to be obtained and being hard to generate a pinhole to a vacuum deposition method is desirable. When adopting this vacuum deposition as this thin film-ization, although it changes with the crystal structures, meeting structures, etc. which are made into the modality of compound to use, and the purpose of a molecule deposition layer, as for the vacuum evaporation condition, it is desirable to choose suitably generally in the boat heating temperature of 50-500 degrees C, a 10<sup>-6</sup> to ten to 3 Pa degree of vacuum, the evaporation rate of 0.01-50nm/second, the substrate temperature of -50-300 degrees C, and the domain of 5nm. The thin film which consists of the matter for cathode after formation of these layers and on it is made to form by technique, such as vacuum evaporation and sputtering, so that 1 micrometer or less may become the thickness of the domain of 50-200nm preferably, and a desired EL element is obtained by preparing cathode. In addition, in production of this EL element, it is also possible to make production sequence reverse and to produce it in the order of cathode, an optical-absorption diffusion layer, an electron-injection layer, an organic luminous layer, a hole-injection layer, and an anode plate.

[0020] moreover, as the production technique of the element which consists of the anode plate / mixolimnion / an optical-absorption diffusion layer / cathode pinched in the type where it made inter-electrode [ of a couple ] mix a hole-injection layer, an organic luminous layer, and an electron-injection layer. For example, [ whether the solution which forms the thin film which consists of the matter for anode plates on a suitable substrate and consists of binders, such as a hole-injection material, luminescent material, an electron-injection material, a polyvinyl carbazole, a polycarbonate, a polyarylate, polyester, and a polyether, etc. is applied and ] Or there is a thing in which make a thin film form by the dip-painting method of construction from this solution, consider as a mixolimnion, form an optical-absorption diffusion layer on it, and the thin film which consists of the matter for cathode further is made to form. Thus, photogenesis can be observed, if it impresses + for an anode plate and it impresses about [ voltage 5-40V ] for cathode as a polarity of -, in impressing direct current voltage to the obtained organic EL element.

Moreover, even if it impresses a voltage by the reverse polarity, photogenesis is not produced at all, without a current flowing. Furthermore, light is emitted, only when alternating voltage is impressed, a positive electrode changes + and a negative electrode changes into the status of -. In addition, the wave of the alternating current to impress is arbitrary and is good.

[0021]

[Example] Next, although an example explains this invention still in detail, this invention is not limited at all by these examples.

What produced ITO electrode in thickness of 100nm on the glass substrate of an example 125mmx75mmx1.1mm size was used as the transparent support substrate. After cleaning this ultrasonically for 30 minutes by isopropyl alcohol, the pure water washed for 30 minutes and, finally it cleaned ultrasonically for 30 minutes by isopropyl alcohol again. Next, it fixed to the substrate electrode holder of the vacuum evaporation system [the product made from Japanese Vacuum technology] of marketing of this transparent support substrate, N, N'-diphenyl-N, N'-screw-(3-methylphenyl)-[1 and 1'-biphenyl]-4, and 4'-diamine (TPD) 200mg was put into the resistance heating boat made from \*\*\*\*\*, and 200mg (Alq) of tris (8-hydroxyquinoline) aluminum complexes was put into another resistance heating boat made from \*\*\*\*\*.

Moreover, the graphite was set to arc vacuum evaporatio equipment. After decompressing the inside of a vacuum chamber up to  $1 \times 10^{-4}$  to 4 Pa, heated the boat containing TPD, TPD was made to deposit on a substrate, and the hole-injection layer of 60nm of thickness was formed.

Subsequently, it carried out 60nm laminating deposition from another boat, having used Alq as the luminous layer. Besides 30nm of graphites was made to deposit by the arc vacuum deposition, and the optical-absorption diffusion layer was established. ITO/TPD/Alq3/graphite/cathode

[0022] Next, this was taken out from the vacuum tub, the mask made from a stainless steel was installed on the above-mentioned luminous layer, and it fixed to the substrate electrode holder again. After having put silver wire 0.5 g into the basket made from a tungsten and putting magnesium ribbon 1g into another boat made from \*\*\*\*\*, the inside of a vacuum tub was decompressed up to  $1 \times 10^{-4}$  to 4 Pa, the vacuum evaporatio of magnesium and the silver was carried out by the atomic ratio 10:1, and the cathode was produced. Thus, it was 80 when contrast was searched for by the technique shown below about the obtained element.

<the measuring method of contrast> -- while the photogenesis side was turned up and the element was first placed on the predetermined base under fluorescent lamp lighting in a usual laboratory, the incandescent lamp (100W) has been arranged in about 50cm distance on the slant of this element and the brightness at the time of impressing the voltage of 9V to an element, turning on an incandescent lamp, and making this element emit light and brightness when not impressing the voltage to an element -- a color color difference meter (CS[ by Minolta Camera Co., Ltd. ]-100) -- measuring -- brightness ][ at the time (at the time of photogenesis) of formula contrast = [voltage impression ]/[brightness when not impressing the voltage (at the time of un-emitting light)]

Contrast was computed more. In addition, the optical environment at the time of the measurement of luminance imitates the typical optical environment at the time of an organic EL element actually being used.

[0023] It was made to deposit to Alq layer like an example 1 except having not prepared an example 2 graphite layer. Next, the lithium was put into the boat made from molybdenum, and the graphite was set to the arc evaporator, it decompressed to the  $1 \times 10^{-4}$  to 4 Pa degree of vacuum, vapor codeposition of a lithium and the graphite was carried out so that it might become an atomic ratio 1:99, and the mixed electrode (cathode which has Li concentration 1 atom % and an optical-absorption diffusibility) of a lithium and a graphite was prepared on Alq layer. Thus, it was 78 when contrast was searched for like the example 1 about the obtained element.

[0024] In example of comparison 1 example 1, except having not established an optical-absorption diffusion layer (graphite layer), when the organic EL element was produced like the example 1 and the contrast was searched for, it was 11 and was remarkably low compared with the element obtained in the example 1 and the example 2.

[0025]

[Effect of the Invention] The organic EL element of this invention establishes an optical-

absorption diffusion layer with an organic luminous layer between the electrodes of a couple, or prevents reflex of outdoor daylight by making it what has an optical-absorption diffusibility for any of the electrode of a couple, or one side, and raises contrast remarkably. The organic EL element of this invention is suitably used as a light emitting device in various display.

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[Translation done.]

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